Electromyographic Analysis of Low Back Muscles of Occupational Workers during Rehabilitation Exercises

Synopsis

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1. INTRODUCTION

With a global lifetime prevalence of approximately 40% [1], low back pain (LBP) causes a considerable burden on occupational workers [2]. Besides, negative effects for workers, consequences of LBP include productivity-loss at work [3], sickness absence [4] and disability [5]. LBP is one of the most common subjective health complaints [6]. In Britain, the 1 year prevalence was 49% [7] and in the Nordic countries the 1 month prevalence of LBP was 35% [6]. It is also one of the most common causes of sick leave and disability pension in the world [8].

2. LITERATURE REVIEW

LBP occurs due to injury or overuse of muscles, ligaments and joints in the spine canal. The common cause of LBP among occupational worker are lifting a heavy object, twisting action, or a sudden movement [9]. Various interventions have been tried both to prevent [10] and to treat [11] LBP. Exercise therapy is utilized extensively as an intervention for patients with LBP. Many studies show that patients with chronic LBP may benefit from appropriate exercise programs. A wide variety of exercises have been utilized for progressive strengthening of the low back. Electromyography (EMG) provides a means by which the back muscle activation levels can be analyzed during exercises, which can assist a therapist in selecting appropriate exercises. McGill [12] and Kavcic et al. [13] have provided extensive EMG data of the back muscles during a

variety of low back exercises, while others have also performed EMG studies focusing more on specific exercises [14-17]. Some exercises have yet to be studied using EMG analysis. Many studies have analyzed the longissimus thoracis and lumber multifidus muscle activity with surface EMG during a variety of exercises often used in back rehabilitation programs. It is commonly accepted that the impairment in the mechanical stability of the lumbar spine musculature can influence muscle recruitment patterns and contribute to the occurrence of the LBP symptoms [18].

In low back rehabilitation, there are four main muscles involved, namely, longissimus, spinalis, lliocostalis lumborum, and external oblique, which work together to support the spine, help hold the body upright and allow the trunk of the body to move, twist and bend in many directions.

2.1 ELECTROMYOGRAPHY AND ELECTROENCEPHALOGRAPHY

Electromyography is widely used to analyze human movement in occupational biomechanics [19]. EMG provides data for individual muscles. To understand EMG, it may be noted that all living cells are surrounded by a membrane, which is selectively permeable to various ions and also actively transports ions, and therefore there exists a resting membrane potential. This potential is typically in the order of -70 to -90 millivolts (mV) for an axon or muscle fiber, with the outside positive relative to the inside. A depolarization of a cell to a threshold value initiates an action potential as the membrane's permeability changes. When generated in a motor nerve neuron, the nerve action potential (NAP) propagates along the cell's axon down to the motor endplate. A series of NAPs over time is referred to as a NAP train. At the motor endplate the NAP train causes the release of chemical transmitters that activate depolarization of the muscle fibers. When the NAP propagates down the motor neuron it normally activates all its branches, and these in turn activate all the muscle fibers of the motor unit. When the muscle fiber

membrane is depolarized, the depolarization propagates in both directions along the fiber, causing a wave of contraction that produces a brief twitch and subsequent relaxation. The depolarization of the muscle fiber membrane represents a small electrical potential known as a muscle action potential (MAP), and a series of these over time is called a MAP train. Since not all muscle fibers of a motor unit depolarize and contract simultaneously, a complex motor unit potential (MUP) results from the superimposition of several muscle fiber MAPs. By placing an electrode either within the muscle (i.e., an indwelling or intramuscular electrode) or on the skin (i.e., a surface electrode), these potentials can be recorded. Such measurement is called electromyography (EMG). Each muscle has a number of motor units. An increase in tension can occur either by an increase in the stimulation rate of a given motor unit or by the recruitment of additional motor units. Thus, the recorded EMG voltage is normally the sum of several MUPs.

Electroencephalography (EEG) is an electrophysiological monitoring method to record activity of the brain. It is typically noninvasive, with the electrodes placed along the scalp, although invasive electrodes are sometimes used such as in electrocorticography. EEG measures voltage fluctuations resulting from ionic current within the neurons of the brain. EEG, a valuable tool for diagnosis and research, has been widely used to analyze meditation states of brain [20].

2.2 REHABILITATION EXERCISES

Rehabilitation exercise is systematic, planned performance of bodily moments, posture, or physical activities intended to provide an occupational worker with the means to (1) remediate or prevent impairments, (2) improve, restore or enhance physical functions, (3) Prevent and reduce health related risk factors, (4) Optimize overall health status, fitness or sense of well- being. The beneficial effects of rehabilitation exercise for individuals with a wide variety of health

conditions and related physical impairments are documented extensively in the scientific literature [21-23].

3. PROPOSED RESEARCH WORK

In this research work, it is proposed to perform EMG experiments on two sets of workers during selected exercises viz. (1) workers having LBP, and (2) workers with no history of LBP. Likely sample size of both type of workers would be 30 each thereby a total of 60 workers. Demographic data (name, age in years, height in centimeters, weight in kilograms and work-experience in years) of each subject would be recorded. Body mass index would also be calculated using height and weight data of each subject. A brief demonstration of EMG equipment and exercises would be given, and informed consent would also be obtained prior to experiments from each subject.

The primary reason for recording and processing EMG signals in the proposed work would be to evaluate stress levels in low back muscles during different occupational tasks taken up in the study. The relationship of EMG activity to muscle force is usually monotonic, i.e., an increase in tension is paralleled by an increase in EMG activity. However, it becomes nonlinear under some circumstances. EMG signals processed by means of full-wave rectification, and low-pass filtering techniques have been used extensively to study EMG-force relationships.

It is also proposed to include yogic exercises as part of rehabilitation exercises to alleviate LBP. Yogic exercises have been scientifically validated for their beneficial effects on human body in general [24]. These exercises self regulate not only the body but also mind, thereby affecting mental health positively by engaging a specific attentional set. It is intended to use electroencephalography to analyze the effects of yogic exercises on changes in the levels of LBP. The fact that different conscious states are accompanied by different neuro-physiological states

and the brain electrical activities measured would reflect these changes explains the use of EEG for such studies [25]. Experimenting with yogic exercises to alleviate LBP would further add novelty in the proposed research work.

The effect of manual material handling (MMH) tasks during work on the incidence of LBP would be assessed, and the impact of these relationships on the occurrence of LBP on workers exposed to MMH tasks would be quantified. Duration, frequency and intensity of lifting tasks would be found out by actual observations on factory sites.

4. OBJECTIVES

In the proposed research work, it is intended to achieve the following objectives:

1. To analyze activity of selected muscles during rehabilitation/yogic exercises used in low back rehabilitation programs on workers with no history of LBP.
2. To assess the effect of manual material handling (MMH) tasks during work (quantified in duration, frequency or intensity in case of lifting) on the incidence of LBP and to quantify the impact of these relationships on the occurrence of LBP on workers exposed to MMH tasks.
3. To evaluate the effect of controlled workplace interventions on low back pain. The rising costs of employees with LBP have resulted in an abundance of offers to organizations of interventions to prevent and/or treat the problem. Little is known of the effect of the exercises interventions.
4. To investigate the effects of selected rehabilitation exercises on electromyography activity of selected muscles to alleviate LBP of different occupational workers near Agra.

5. SCHEDULE OF PROPOSED RESEARCH

1. Data collection from different industrial units near Agra: 6 months
2. Experimental studies to record activity of selected muscles of different occupational workers in the lab: 1 year
3. Statistical analysis of compiled data: 6 months
4. Analysis of results: 6 months
5. Detailed discussion of results and thesis writing: 6 months

6. CONCLUSION

The proposed research work would be useful in designing appropriate rehabilitation programs to alleviate low back pain of occupational workers. This in turn would also help in improving labor productivity of manufacturing organizations employing such workers.

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